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TO MALARIA AND YELLOW FEVER

William C.Gorgas

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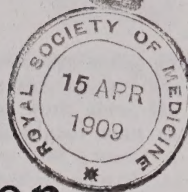
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SANITATION OF THE TROPICS WITH SPECIAL REFERENCE TO MALARIA AND YELLOW FEVER *

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If we go back to the year 1898 and consider the point of view of Europeans and their American descendants about to enter the tropics, yellow fever to them was by far the most dangerous disease with which they were likely to come in contact. I am referring now principally to the American tropics, as yellow fever affected principally this region. And this was particularly the case when it was intended to send large bodies of non-immune persons, such as our army of occupation in Cuba. Yellow fever had caused more disaster to military expeditions going to these tropics than had all the other tropical diseases put together, and it had been equally fatal to non-immune individuals in civil life. Our military surgeons, therefore, in their sanitary recommendations considered more particularly this disease.

Yellow fever frequently affected the southern portions of the United States, and military surgeons were very confident of their ability to manage it as it affected small bodies of troops, such as were stationed in the southern portions of the United States. While they knew that they could not eradicate it from a locality in which it had taken hold, their experience had taught them that by marching a small command a few miles out into the country this command would be entirely safe for a considerable length of time. This was the only measure that they knew of at that time whereby considerable bodies of men could avoid this fatal disease; that is, they could move away from the infected locality and would not carry the infection with them.

With a considerable army in active military operations, however, this method can not always be carried out, as military necessity would frequently require the army to remain in the infected locality. For the above reasons the Army Medical Corps at this time concentrated its attention on the prophylaxis of yellow fever. For two years the sanitary authorities tried by all then known sanitary means to free Havana from yellow fever. Havana at that time was properly looked on as the center from which yellow fever frequently spread to all the neighboring regions in North, Central and South America. Yellow fever had never entirely disappeared from this city for a hundred and fifty years previous to this time. Non-immune population coming in all the time furnished sufficient fuel to keep this disease constantly active.

By February, 1901, we found that after two years of steady sanitary work we had made no impression on yellow fever in Havana. Instead of this disease decreasing, we found that it had rather increased as the non-immune population increased. A board of army medical officers had been especially detailed for the investigation of this work. They did a great deal that bore no particular fruit, but they finally found that Dr. Carlos Finlay, a distinguished physician of Havana, had been maintaining for the previous twenty years that a particular mosquito, the *stegomyia*, transmitted yellow fever from person to person. They took the matter up, experimented on human beings who volunteered for this purpose, and proved that yellow fever was transmitted in this way and probably in no other way. I think this work, as conceived by Dr. Reed, the chairman of this commission, is the most mathematically convincing experimental work ever carried out on a medical subject. The results were announced in the spring of 1901 and have since been accepted by all the scientific world. The sanitary authorities of Havana at once instituted measures based on this knowledge obtained by the Army Medical Board, and in less than a year yellow fever was entirely eradicated from Havana. Since that time the same measures have been tried at other places, and sufficient success has been attained to establish these measures as the routine to be adopted in freeing a municipality from yellow fever.

We have been equally successful in freeing the city of Panama, the city of Colon and the Canal Zone from yellow fever, although it was rife here when we came, and although we have introduced some 30,000 non-immunes from the United States since that time. In order to make our methods clear I will describe what I would consider a model organization for caring for a municipality of that size. Mind you, I am describing a model organization, not what we have, but what we would like to have. We have succeeded in getting yellow fever out of Panama, but it could have been done much more expeditiously with a better organization. I write this description for the benefit of men who are undertaking municipal sanitary work of this kind. I think it advisable to always try to get the very best, and then to go ahead and do all one can, on the best that one can get.

The *stegomyia*, the mosquito which transmits yellow fever, is a mosquito which infests cities and towns and the dwelling-houses of man. It breeds principally in rain-water barrels, cisterns, wells, house gutters, etc. Therefore, the chief work of sanitation would be done from the urban centers, through the municipal sanitary organization.

The first thing in undertaking such a work is to get the necessary funds, and to establish some system of account-keeping which will both protect the officer disbursing the funds and not be too cumbersome in admin-

* Paper read before the Fourth Pan-American Scientific Congress, Dec. 25, 1908, Santiago, Chile.

istration. The next step is to get the authority necessary for enforcing the sanitary measures. To this end I would have an ordinance passed declaring it a nuisance for any property owner to have on his premises any mosquito larvæ, and prescribe a fine of from \$5 to \$10 for such offense. The sanitary officer should have powers, as far as these sanitary ordinances are concerned, such as the *alcaldes* of most Latin-American municipalities have. This would give the sanitary officer the power of assessing the fines or of revoking them at any stage of the proceedings. The fine should be collected through the courts, but the sanitary officer should be officially informed by the judge when the fine is collected, and also by the treasurer when the fine has been deposited in the treasury. In this way he can keep control of all the steps in the process.

Another ordinance should be passed giving the sanitary officer authority to abate these nuisances himself with his own force when they have not been abated by the owner of the property after a week's notice, and providing that the cost of such work be made a lien against the property, which cost is to be collected through the courts against the owner of the property. This is a very important measure, as it enables the sanitary officer at no great public expense rapidly to carry into effect his sanitary measures himself when the people affected are slow in executing the measures ordered.

A third ordinance should be passed directing that all cisterns, wells, gutters and water collections likely to breed mosquitoes must be either abolished or so screened and cared for that mosquitoes can not breed in them. With these three ordinances the health officer can rapidly get his community in such condition that very few *stegomyia* can breed, and the locality will soon be in such condition that there will be so few *stegomyia* that yellow fever can not spread.

The municipality should then be divided into inspection districts, each district to contain about 600 houses. An intelligent inspector should be placed in charge of each one of these districts and required to make a written report on every house in his district once a month concerning its sanitary condition. (An intelligent inspector should readily inspect twenty-five houses a day on the average.) His report should show the condition of the houses and premises, more particularly with regard to mosquito breeding places; how many receptacles actually had larvæ; how the barrels and cisterns were with regard to the screening; how the gutters were with regard to containing water, and as to whether there were other receptacles on the premises which were likely to breed mosquitoes. This report should go to the office daily, and the health officer should base his action thereon. The health officer should notify the owner of the premises to correct the nuisance reported by the inspector, and if on reinspection, which should be made at the end of the week, the nuisance was found to be still unabated, then the health officer should send his "cleaners" around who should clean up the premises. The inspector in charge of the cleaning squad should keep an accurate account of the expenses and this should be charged up against the property owner. If cisterns, barrels, etc., needed screening, gutters repairing, etc., the general carpenter should go around with his squad, put the property in good condition, keep an accurate account of his expenses, and charge this to the property owner. If it is a suburb of the town, and ditching and draining is needed, the health officer should send the inspector in charge of the draining squad out, who should

see that the necessary ditching is done, rendering an account of his expenses and charging this against the property owner. For this phase of the work, then, the health officer should have a very intelligent man as inspector, at the rate of one to every 600 houses; a good inspector with a sufficient number of men to do the general cleaning up; an intelligent foreman carpenter in charge of a sufficient number of carpenters to do the necessary screening of cisterns, barrels, etc. All receptacles should be fixed by this squad so that they can not breed mosquitoes. Cisterns should be thoroughly covered and the hole that is left for the water to enter should be screened so that mosquitoes can not gain access to the cistern. Water barrels should be covered in the same way and a cheap wooden spigot placed near the bottom. Gutters should be so fixed that they will not retain water. If a general water supply can be introduced into the city the matter is much simplified, as then all receptacles for storing water can be done away with.

Such an organization, in my opinion, is all that is essential for yellow fever prophylaxis. While street cleaning, garbage collection, caring for night soil, etc., are very useful adjuvants to the general health and good appearance of the municipality, they have no direct bearing on yellow fever, and the people of a poor community, that had little money to spend, would be entirely justified, I think, in adopting the organization outlined, with the idea of keeping it up for a year or two, freeing their locality from yellow fever, and considering the other municipal work mentioned at some future time when they would be better able financially to carry it out.

The actual cost for a small municipality of about 600 houses, with an approximate population of 3,000 people, would be as follows:

	Monthly Salaries.
1 Health officer	\$400
1 Clerk	125
1 Sanitary inspector	125
1 Chief carpenter	125
1 Head cleaning squad	125
1 Head ditching squad	125
20 Laborers at \$30	600
Material	275
Total	\$1,900

These are maximum figures and would probably not be paid under ordinary circumstances. They are based on the rates and salaries that at present prevail at Panama.

In addition certain measures should be carried out looking to the caring for the sick. An ordinance should be passed requiring all yellow fever suspects to be reported at once to the health officer. As soon as a case is reported the health officer, if he considers it yellow fever, should have the patient isolated at once, either by being sent to the hospital, which hospital should be carefully screened, or he should have the room where the patient is lying screened. I think it best to leave this to the choice of the patient. If the patient elects to stay at home the screening should be so done that there would be only one door of entrance, and this door should be guarded by a watchman of the sanitary department whose duty it is to see that no one has access to the patient except those authorized by the health officer; this with the object of seeing that non-immunes do not go and come.

After the case has terminated the building occupied by the sick person, and the contiguous buildings, should be fumigated with some good insecticide. I prefer sulphur wherever possible. Where sulphur can not be used I recommend pyrethrum. It is very important that the man at the head of affairs should have a thorough knowledge of the details of all these matters. He should know whether the screening is properly done; when fumigating, whether the pasting has made the building sufficiently tight, etc. It requires considerable experience to become expert in all these details, and a mere theoretical knowledge is at first not of much avail.

For the small community, above described, these measures of caring for the sick and destroying infected mosquitoes need not add to the force. The health officer himself would have plenty of time to look after the sick. The chief carpenter with his squad could do the screening, and the inspector in charge of the cleaning squad could do the fumigating.

The relative cost would, of course, decrease as the size of the municipality increased. Take a municipality ten times the size of the one described, with a population of about 30,000 people, who would live in some 6,000 houses. The personnel would be increased about as follows:

	Monthly Each.	Salaries. Total.
1 Health officer	\$400	\$400
10 Sanitary inspectors	125	1,250
2 Clerks	125	250
1 Chief carpenter	125	125
2 Carpenter foremen	75	150
1 Head of cleaning squad.....	125	125
4 Foremen	75	300
1 Chief of ditching squad.....	125	125
1 Foreman	75	75
60 Laborers	30	1,800
Material	400	400
Total		\$5,000

Here you see that our unit of 600 houses, instead of costing \$1,900 per month, would cost only \$500 per month, and, of course, as the municipality increases in size the cost per unit would continue to decrease. In this estimate for a large municipality I am not including the cost of care of the sick, as the municipality of this size would necessarily have some hospital in which the sick would be cared for.

In the municipality the same measures that are directed against yellow fever will avail against malaria. This has occurred in Havana, Cuba. The anti-mosquito work done there in the past ten years has practically eliminated malarial fever. The deaths from malaria prior to 1896 averaged about 250 per year. This has gradually fallen until in the last year or two they have had less than fifty deaths per year. In a city situated as is Havana, this, I think, means the extinction of malaria. The fifty deaths occurring every year at present in Havana, due to malaria, are probably caused by the persons affected by malaria who come in from the rest of the island. Havana is the metropolis of Cuba; all the large hospitals are located there, and a great many people, whenever taken sick, come in from all parts of the island to these hospitals for treatment. In the ordinary course of affairs a large number of malaria patients come into the city from the rest of the island in connection with their routine business.

Great strides in diminishing the spread of yellow fever all over the world have been made in the last ten years. Ten years ago the four principal centers of yellow

fever in the world were Vera Cruz, Havana, Rio Janeiro and Guayaquil. Of these Havana and Rio Janeiro were much more important centers of infection than Vera Cruz and Guayaquil. From Havana yellow fever has practically been eliminated, and within the last six months Rio Janeiro has been almost as successful. In Vera Cruz yellow fever has become sporadic instead of being endemic. Sporadic cases within the last year have occurred in several different parts of tropical America, and a few on the west coast of Africa, but nothing comparable with what it was ten years ago. It seems to me that yellow fever will entirely disappear within this generation, and that the next generation will look on yellow fever as an extinct disease having only a historic interest. They will look on the yellow fever parasites as we do on the three-toed horse—as an animal that existed in the past, without any possibility of reappearing on the earth at any future time.

Concerted effort on the part of the countries in which it now occurs, I think, would extinguish the disease at once at no very great expense and without undue labor. I believe that if this congress could get the governments of the various countries in which yellow fever has occurred during the past year to agree to keep such an organization as I have outlined, which could be sent at once to the locality where yellow fever appears, and there stamp it out, at the end of two years yellow fever would have disappeared from the western hemisphere.

THE FUNCTION OF THE END-ORGANS IN THE VESTIBULE AND SEMICIR- CULAR CANALS

AND SOME METHODS FOR EXAMINING THESE CANALS IN
PRACTICAL DIAGNOSIS

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CHICAGO

In order to understand the disturbances in function arising from the diseases of the vestibule and semicircular canals, as well as the principles involved in diagnosing these conditions, it is necessary that one keep clearly in mind a few fundamental facts in regard to the anatomy and the physiology of these structures.

Only a few years ago physiologists looked on the internal ear as a mechanism that had to do solely with the function of hearing. This function they assigned to the three parts of the labyrinth as follows: To the end-organs in the cochlea was attributed the function of tone perception; to the end-organs in the vestibule the function of noise perception, and to the semicircular canals was attributed the function of determining the direction from which sound comes.

The more recent studies of the internal ear justify the conclusion that the cochlea alone is interested in sound perception, whether this be in the nature of noises or musical tones, and that the end-organs in the vestibule and semicircular canals have to do with the important function of preserving the equilibrium. This latter function is accomplished by these several end-organs as follows: From the vestibule we get our knowledge of position in space; from the semicircular canals our knowledge of turning motions. The data derived from these two sets of end-organs seems to be sufficient to account for the function of equilibrium.

The function attributed to the vestibule is accomplished as follows: There are located in the vestibule two end-organs, identical in structure, but placed on

